

## लोक सेवा आयोग

नेपाल स्वास्थ्य सेवा, विविध समूहको आठौं तह बायोमेडिकल इञ्जिनियर पदको पाठ्यक्रम

पाठ्यक्रमको रूपरेखा :- यस पाठ्यक्रमको आधारमा निम्नानुसार दुई चरणमा परीक्षा लिइने छः

प्रथम चरण :- लिखित परीक्षा

द्वितीय चरण :- अन्तर्वार्ता

प्रथम चरण :- लिखित परीक्षा योजना (Examination Scheme)

पत्र	पद	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या X अङ्कभार	समय
प्रथम	बायोमेडिकल इञ्जिनियर	१००	४०	वस्तुगत बहु वैकल्पिक (MCQs)	१०० X १ = १००	१ घण्टा १५ मिनेट
द्वितीय		१००	४०	विषयगत (Subjective)	१० X १० = १००	३ घण्टा

**Paper I and II: Technical subject**

**Section (A): 30 %**

1. **Bio-Engineering Materials and Components**
  - 1.1 Introduction to bio-materials and Classes of materials used in medicine
  - 1.2 Types of polymers used in medicine, Molecular weight and synthesis, Solid-state polymers and copolymers, Characterization techniques, Hydrogel
  - 1.3 Structure, chemistry and properties of ceramics and glasses used in medical devices; Types of bio-ceramics; Characteristics and processing of bio-ceramics; Inert crystalline ceramics; Porous ceramics; Bioactive glasses and glass ceramics; Calcium phosphate ceramics, resolvable calcium phosphates
  - 1.4 Different types of natural materials; Structure of native collagen; Physical modification of the native structure of collagen; Chemical modification of collagen; Proteoglycans and glycosaminoglycans; Elastin, Graft copolymers of collagen and glycosaminoglycans
2. **Human Anatomy**
  - 2.1 Anatomy and its branches, Anatomical positions, planes, Topography
  - 2.2 Cell Anatomy: Overview of Cellular Anatomy
  - 2.3 Extremities (Upper and Lower): Bones, muscles, ligaments, tendons, bursae, reticulae, capsules, arteries, veins, Lymphatic system,
  - 2.4 Vertebral Anatomy: Vertebrae, Pelvic girdle, spinal cord, nervous system, Thorax- Thoracic Viscera: Surface anatomy, bones surface musculature, lungs, heart, Abdomen: Organs (location, structures, relations and function), Head & Neck: Bones, muscles, cranial nerves (location, structures, relations and function)
3. **Human Physiology**
  - 3.1 Functional organization of human body and control of the internal environment
  - 3.2 Cell and its function, protein synthesis and cell reproduction
  - 3.3 Metabolism of carbohydrates and formation of ATP
  - 3.4 Lipid and Protein Metabolism, transport through Cell membrane
  - 3.5 Quantitative issues at the organ and whole body levels of: Cardiovascular, Respiratory, Renal and Digestive systems
  - 3.6 Nerve and Muscle: Membrane potential, Action potential, Excitation and Rhythmicity
  - 3.7 Contraction of Skeletal and cardiac muscles, sliding filament Mechanism, Heart as a pump
  - 3.8 Sensory Systems: Sensory Receptors: Classification and basic mechanism of action, Somatic Sensations: Mechanoreceptive sensations, pain, thermal and visceral pain, headache, Special Senses: Eye, receptor function of the retina, Neurophysiology of Vision, the Chemical Sense-taste and smell, Nervous System: Organization of Nervous System, Basic functions of synapses; Neuronal Mechanism and circuits for processing information, Motor Functions: Spinal cord and the cord reflexes; the cerebral cortex and intellectual functions of the Brain.

- Motor function of the Brain stem. Vestibular control of postural reflexes, Cerebrum and basal ganglia.
- 3.9 Reticular formation, Behavioral functions of the Brain: Limbic System, role of the Hypothalamus, and control of the vegetative functions of the body; the Autonomic nervous system; the Adrenal Medulla. Electrical Activity from Brain.
- 3.10 Endocrinology and Reproduction: Introduction to Endocrinology and the pituitary Hormones; Hormonal functions in male and female
4. **Biophysics**
- 4.1 Sound: Hearing and Echolocation, Ultrasound
- 4.2 Optics of Vision: Quantum Nature of Vision
- 4.3 Nervous system: Biophysics of Neural Spike. Information theory and Memory; Nervous system
- 4.4 Radiation and Radiobiology: Interaction of radiation with matter, Biological effects of radiation, radiobiological effects of radiation, medical imaging using radio-isotopes
- 4.5 Biopotentials: Electrocardiograms and electric shocks,
- 4.6 Fundamental laws for current in biological tissues, Biopotentials in hearts, electrocardiogram, Action potentials in nervous system
5. **Biochemistry**
- 5.1 Colloidal state, buffer, pH, significance of pH Henderson equation, surface tension, viscosity, osmosis, diffusion
- 5.2 Concept of chromatographic techniques (TLC, paper chromatography, GLC column chromatography)
- 5.3 Carbohydrates, amino acids, nucleic acids, proteins, vitamins, enzymes, hormones and signaling agents, carbohydrate derivatives, optical activity, polarimetry, glycogenesis, gluconeogenesis, glycolysis, tricarboxylic acid cycle, hexose monophosphate shunt
- 5.4 Effects of hormones on carbohydrate metabolism
- 5.5 Chemistry and Metabolism of Lipids and Proteins
6. **Bio Fluid Mechanics**
- 6.1 Basic concepts in fluid mechanics: Viscosity, surface tension, compressibility; hydrostatics, pressure on plate; kinetics & kinematics of fluid flow; continuity equation; conservation of momentum; Bernoulli's equation; Poiseuille equation; viscous, unsteady flows; dimensional analysis
- 6.2 Physiological Fluid Mechanics: Introduction to blood flow in the circulatory system, respiration, peristaltic motion, ciliary and flagel
7. **Fundamental of Electrical Engineering**
- DC and AC Series And Parallel Circuits, Kirchhoffs Law, Network Graph, Matrix Representation - Solution Of Steady State, equations, transients in AC networks, Network theorems, super position, reciprocity, Thevenin and Norton's theorems, Maximum power transfer theorem, star delta transformation, frequency response of RL, RC, RLC series and parallel circuits, solutions of balanced and unbalanced 3 phase circuits

8. **Electronic Devices and Circuit**

Bipolar transistors switching characteristics, MOS transistor switching characteristics, TTL logic circuits, NMOS/CMOS logic circuits. Memory: RAM, DRAM, PROM, EPROM, Operational amplifiers, Butterworth and Chebysev filters, A/D Converters, Adders, Arithmetic operations, Digital comparators, Parity check generator, Multiplexer & Demultiplexers, Flipflops, Shift register, Counters, Sequence generators. Power electronics: Thyristor, Controlled rectifier circuits, 7 segment display, Untuned amplifier, Push-pull amplifier, tuned power amplifiers, Feedback amplifiers, bode plot analysis, Wien bridge oscillators, tuned LC oscillators, resonant circuits, crystal oscillator.

9. **Digital Logic and Microprocessor**

Switching algebra, Number systems, Logic gates and circuits, Minimization techniques, Logic families, shift registers, Counters, Multiplexer, Demultiplexer, semiconductor Memories, LSI, VLSI, 8, 16, 32 and 32 bit microprocessors and their architecture, Instruction set, Peripherals and Interfacing Microcontrollers Microprocessor based system design

10. **Biomedical Signal Analysis and Processing**

Information theory, Shannon-Hartley law, Transmission of signals, Impulse response and convolution, Fourier series, Fourier Transform, Unit step, Delta, Sinc & Signum function, Helbert transform, LTI system, System described by Differential & Difference equations, FIR & IIR Filters, Discrete Fourier Transforms, IDFT, FFT, Circular convolutions, Parseval's theorem, Energy & power and auto correlation, Z transform

11. **Biomedical Electronics**

Amplifier Characteristics: Input and output impedance, Real and Apparent gain, Amplifier loading, Impedance matching of amplifiers, Power Supplies: Regulated and switched mode power supplies, Power Amplifiers: Classes of Power amplifiers, Oscillators: Hartley oscillators, Colpitt oscillators, RC phase shift oscillators, WeinBridge oscillators, Crystal oscillators based on BJT and FET, Differential Amplifiers: Darlington transistor circuit, properties of differential amplifier stage, circuits of differential amplifiers using BJTs and FETs, Operational Amplifiers: Analysis of OP- AMP action, OP-AMP specifications: interpreting OP-AMP data sheet, offset voltage and current, temperature rating, output swing, CMRR, slew rate, Applications: Inverting amplifiers, non-inverting amplifiers, voltage follower, summing amplifiers, instrumentation amplifiers, integrator, differentiator, non linear amplifiers. Frequency response of OP-AMPs, A/D and D/A converters, power control using Op-amp, Op- Amp based timing circuits.

**Section (B): 40 %**

12. **Biomedical Instrumentation**

12.1 Precision, resolution, sensitivity, accuracy, uncertainty, Principles and development of Biomedical Instrumentation, Problems encountered in living systems, Biological Systems: Study of various physiological systems, related biopotentials and physiological parameters

- 12.2 Diagnostic Equipment: invasive and noninvasive measurement, techniques and related equipment
- 12.3 Cardiovascular Measurements: Electrocardiography, Measurement of Blood pressure, Blood flow and Cardiac output, Biofeedback Instrumentation
- 12.4 Biomedical Sensors and Transducers: Introduction, principles, theory, design and applications, Principles and design, Speed, Position, Temperature, light & Pressure transducers, Programmable logic controller, PLC interfacing, memory processor,
- 12.5 Patient Monitoring Equipment: Patient Monitors, Central Monitoring System, telemetry system, Gas Exchange and distributions, Respiratory therapy equipment,
- 12.6 Cardiovascular and pulmonary Equipment:
  - 12.6.1 IABP
  - 12.6.2 LVAD
  - 12.6.3 Defibrillator a) Implantable cardioverter defibrillator b) External defibrillator
  - 12.6.4 Pacemaker
  - 12.6.5 Heart Lung machine
  - 12.6.6 Ventilator, anesthesia, inhaler etc
- 12.7 Radiological Equipment: concept of ionization and nonionization radiation and related equipment, medical lasers and applications, Laser Safety
- 12.8 Safety in Medical Equipment: Electrical/Mechanical safety, Standards of Medical Devices, Biohazards and Safety Regulations
- 12.9 Quality Assurance and Quality Control: Calibration, maintenance and reparability of monitoring equipment
- 12.10 Microscopy: Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, Spectroscopy: U. V., I. R., NMR & Visible Absorption, Fluorometric Methods, Flame Photometry, Spectrographic Spectroscopy, Circular Dichroism, Mass Spectrometry
- 12.11 Electrochemical methods of analysis: Electrophoresis Chromatography, High Performance Liquid Chromatography, Clinical Chemistry Analysis, Study of different blood components through automated cell-counter, Centrifuging Techniques, Blood Banking and Transfusion, Service Automation, Polymerase Chain Reaction
- 12.12 Surgical Diathermy Machine, Safety Aspects in Electro-surgical Units, Surgical Diathermy Analysers; Physical Therapy : Diathermy, Hydrotherapy, Traction & TMT unit; ENT : Audiometers, Tympanometers, ENT microscope, ENT Drill and Autoscope.

### 13. Biomechanics

Statics: General principles of Statics, laws of triangle, Parallelogram and polygon forces, Equilibrium of rigid body, free body Diagrams. Shear force and bending moments. Application of these forces with analysis in human body, Dynamics: Rectilinear and curvilinear motion, Rotational mechanics, Simple and multiple degrees of freedom, Application of these motions in human body and prosthetics, Fluid Mechanics: Basic

concepts of Fluid Mechanics, Hydrodynamic lubrication of natural and normal synovial joints, Biomedical Applications: Mechanical properties of biological tissues and tissue mechanics, cardiac mechanics and modeling, muscle mechanics, gait kinetics, kinematics and analysis. Stress analysis and application to musculoskeletal system.

#### 14. **Biomaterials and Design**

Biomaterials Science and Review: Hard Tissues and Pathologies, Orthopaedic prostheses, Properties of Natural Tissue Replacements, Biopolymers and Biomaterials: 3D structure of Biopolymers by Bio X-ray diffraction, Biomedical application of chitosan and other Biopolymers, Structure property relationships, Metals – Dental Implants, Bioceramics and Composites, Biocompatibility: Immune System, Corrosion, Deterioration of Non-metallic Materials, Mechanical Factors, Testing of Biomaterials, Applications: Joint Replacements, Fracture Fixation, Soft Tissue Implants, Vascular Implants, Tissue Engineering; Gene Therapy using viral vectors, Materials for Scaffolding.

#### 15. **Medical Imaging**

X-ray Equipment: X-ray tubes, X-ray control and indicating equipment, Filters and grids, Different types of X-ray equipment (portable, fluoroscopy, mammography), Digital Imaging: Introduction, Digital Radiography, PACS (Picture Archiving and Communicating System), Computer Tomography (CT): Basic Principles of CT, Generation of CT, System Components, Recent Advances in CT, Magnetic Resonance Imaging (MRI): Fundamental Concepts, Basic Principles of MRI, Contrast Enhanced MRI, Artifacts in MRI, MR Scanners, Clinical Application, Ultrasonography (USG): Physics of Ultrasound, Construction and Properties of Ultrasound Transducer, Ultrasonic Beam, Modes of Ultrasound Imaging, Doppler Ultrasound, Clinical Application, Contrast Media in Ultrasound Imaging, Recent Advances in Ultrasonic Equipment, Cath lab: Principles of operation, system components and application in heart transplant surgery, Interaction of Radiation with Matter, Scattered & absorbed Radiation, spatial image formation, Imaging Transducers: Various transducers used in medical imaging systems, Imaging development: X-ray Film, Fluoroscopic imaging, Digital Imaging System, X-ray imaging, Film-less radiographic imaging, CT imaging, Emission Tomography imaging, Nuclear imaging, MR Imaging, Functional MRI imaging, Advance imaging modalities PET and SPECT. Emerging areas in medical imaging, Ultrasound Imaging: Ultrasonic imaging, Doppler Imaging, software based estimations and measurement in ultrasonic imaging. Planar and Volumetric analysis techniques, Medical imaging software: Algorithms, techniques, imaging archival and management. Molecular imaging and other advance biomedical imaging techniques and their image manipulation, Quality Assurance and Control in Medical Imaging Equipment: Quality assurance of medical imaging, Evaluation of imaging parameter and related equipment calibration, Diagnostic values, Statistical performance measures.

**Section (C): 30 %**

**1. Act and Regulations**

- 1.1. General knowledge about National Trauma Center
- 1.2. National Health Policy
- 1.3. सार्वजनिक खरिद ऐन, २०६३ संशोधन सहित
- 1.4. सार्वजनिक खरिद नियमावली, २०६४ संशोधन सहित
- 1.5. Ethics in Biomedical Engineering